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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/800,580	03/08/2001	Shuzo Sato	SON-2043	5367

23353 7590 04/01/2003

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EXAMINER
MACKEY, TERRENCE M

ART UNIT	PAPER NUMBER
1765	8

DATE MAILED: 04/01/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/800,580	Applicant(s) SATO ET AL.	
	Examiner Terrence Mackey	Art Unit 1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-111* is/are pending in the application.

4a) Of the above claim(s) *53-111* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-52* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☒ Claim(s) *53-111* are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Election/Restrictions

Claims 53 – 111 are withdrawn from further consideration pursuant to 37 CFR 1.142(b), as being drawn to a nonelected polishing apparatus, there being no allowable generic or linking claim. Applicant timely traversed the restriction (election) requirement in Paper No.7.

Specification

The disclosure is objected to because of the following informalities: the description on page 4 refers to Figures 25D, 25E, and 25F yet these figures have not been provided. Appropriate correction is required.

Additionally, the examiner suggests renumbering Figures 2D, 2E, 3F, 3G, 4H, 4I, 5J, 5K, and 5L to aid in reader in understanding the relationship of these figures to Figures 1A, 1B, and 1C, and similarly feels that renumbering Figures 26D, 26E, and 26F would similarly aid the reader in understanding the relationship of these figures to Figures 25A, 25B, and 25C.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Regarding claim 31, the claim is indefinite because it is unclear whether the claim includes a limitation of forming either or both of a groove and/or a hole. Regarding claim 50, there is no antecedent basis for the phrase "copper film".

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> **A person shall be entitled to a patent unless –**
>
> **(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.**

Claims 25 – 34 and 38 – 39, 41, and 46 – 52 are rejected under 35 U.S.C. 102(e) as being anticipated by Wang et al., US6,440,295. Applicant claims a method for electro-polishing the surface of a substrate having an insulating film with at least a groove or a hole formed therein and an uneven metal film formed thereon, the unevenness corresponding to the step difference of the underlying insulating film, the polishing being conducted by interposing an electrolytic solution between a cathode member and the metal film and applying a voltage between the cathode member and the copper film functioning as an anode, said polishing being repeatedly applied to the substrate until unevenness of the copper film is removed thus flattening projecting portions of the metal film. The metal film may be selected from at least one of Cu, Au, and Ag of an alloy of the same, deposited by a electroplating or electroless plating

process. A barrier film may be disposed between the metal film and the underlying substrate surface. The applied electrolytic voltage is furthermore claimed as being applied in a periodical pulse-like form.

Wang et al. disclose an electro-polishing process for a copper film formed on a semiconductor substrate. Electrically conductive circuitry to be formed on the substrate may be via the damascene process wherein a dielectric layer is formed on the substrate, and an electrically conductive material such as copper is deposited into openings formed therein (see column 7, line1 through column 8, line 15). Wang et al. disclose on column 7, lines 45-49, that a barrier layer such as Ti, Ta, W, TiN, TaN, and WN may be formed on top of the dielectric layer and furthermore disclose on column 7, lines 17-28, that in addition to silicon oxide, various low-k materials may be used for the dielectric layer. Wang et al. disclose the use of a temperature control sensor on column 31, lines 40-42, for controlling the electrolyte solution temperature. Wang et al. also disclose (in column 10, lines 61-66 and reference the entire specification) controlling the electro-polishing process through the applied electro-chemical polarity and power. Figure 42 shows various power supply output wave forms for which is noted will inherently result in a sequence of repeated steps for polishing the metal film on the substrate.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1- 24 are rejected under 35 U.S.C. 103(a) as obvious over Yamazaki et al., US6,242,343, in view of Wang et al, US6,440,295 and further in view of Sandhu et al., US6,099,604. Applicant discloses a method for polishing the surface of a substrate having an uneven copper film formed thereon, the unevenness corresponding to the step difference of the underlying substrate surface, the polishing being conducted by interposing an electrolytic solution comprising a chelating agent between a cathode member and the copper film and applying a voltage between the cathode member and the copper film functioning as an anode to oxidize the surface of the copper film and form a chelate film of the oxidized copper, said polishing being repeatedly applied to the substrate until the chelate film corresponding to unevenness of the copper film is removed thus flattening projecting portions of the copper film. A barrier film may be disposed between the copper film and the underlying substrate surface. The underlying substrate is also claimed as possessing an insulating film formed of various insulative materials (silicon oxide, silicon nitride, low-k dielectrics) having grooves or holes formed therein for use in the formation of electrical interconnections and contacts. The chelating agent is claimed as being selected from quinaldine acid, glycin, citric acid, oxalic acid, or propionic acid. The chelate film may be removed via the application of mechanical action of a polishing abrasive, vibration applied to the substrate, or flushing

of the electrolytic solution. The applied electrolytic voltage is claimed as being monitored to control the progress of polishing.

Yamazaki et al. teach a process for polishing a conductive film to serve as an electrical conductor of a multi-layer interconnect for a semiconductor device through the simultaneous application of electro-chemical and chemical-mechanical polishing. The reference does not teach the repeated removal of metal from the substrate to remove projecting portions of the metal film nor the use of a time-varying current during the electro-chemical polishing not does it disclose applicant's claimed use of various dielectric materials, use of copper as the electrically conductive metal film and associated deposition methods, and the use of a barrier layer.

Wang et al. teaches a polishing process for a copper film formed on a semiconductor substrate. Electrically conductive circuitry to be formed on the substrate may be via the damascene process wherein a dielectric layer is formed on the substrate, and an electrically conductive material such as copper is deposited into openings formed therein (see column 7, line1 through column 8, line 15). Wang et al. disclose on column 7, lines 45-49, that a barrier layer such as Ti, Ta, W, TiN, TaN, and WN may be formed on top of the dielectric layer and furthermore disclose on column 7, lines 17-28, that in addition to silicon oxide, various low-k materials may be used for the dielectric layer. Wang et al. also disclose (in column 10, lines 61-66 and reference the entire specification) controlling the electro-polishing process through the applied electro-chemical polarity and power. Figure 42 shows various power supply output wave forms for which is noted will inherently result in a sequence of repeated steps for polishing the

metal film on the substrate. Wang et al. teach various embodiments for the control of the electrolytic solution flow rate that would inherently result in a flushing action in the removal of electro-chemical reaction products. The reference also teaches on column 11, lines 46-60, the application of oscillating the substrate to even out polishing current distribution that would inherently result in the application of vibratory forces to the substrate. Wang et al. additionally teach on column 31, lines 17-25, monitoring the polishing process through the on in-situ film thickness sensors for controlling the end-point of the polishing process.

Sandhu et al. teaches the use of chelating agents in slurries used for the chemical-mechanical polishing (CMP) of semiconductor substrates. Sandhu et al. teach that chelating agents should be selected to react is polish-resistant surface moieties on the surface to be polished to thereby render the surface moieties easier to remove from the surface. Preferred chelating agents for metal surfaces include polycarboxylic acids, polyamines, polyols, polyethers, and ployetherdiols, and polyetherdiamines (see column 5, line 60 through column 6, line 10). Citric acid and oxalic acid are examples of polycarboxylic acids.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Yamazaki et al. in view of Wang et al. to polish a copper interconnect film formed on a semiconductor substrate having a insulative layer with at least a groove of a hole for formation of electrical connects and/ or contacts as taught by Wang and further to include the use of a chelating agent as

taught by Sandhu et al. to achieve enhanced removal of polish-resistant surface moieties.

Claims 35 – 37 are rejected under 35 U.S.C. 103(a) as obvious over Wang et al., US6,440,295, in view of Sandhu et al., US6,099,604. Wang et al. teaches the previously described steps for polishing an uneven copper film formed on a semiconductor substrate, however the reference does not teach the use of applicant's claimed additives to the electrolytic solution. Sandhu et al. teach the use of an aqueous polishing slurry containing a chelating agent to react with polish-resistant surface moieties on the substrate and make the surface moieties easier to remove with substantially non-aggressive polishing techniques.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the polishing process of Wang et al. in view of Sandhu et al. to include a chelating agent in the polishing slurry to enhance the remove of desired material from the substrate.

Claims 40 and 42 are rejected under 35 U.S.C. 103(a) as obvious over Wang et al., US6,440,295, in view of Uzoh et al., 5,807,165.

Wang et al. teach the above process for polishing a copper film formed on a semiconductor substrate, however the reference does not teach gradually increasing or decreasing the electro-chemical current towards the end of the electro-polishing process. Uzoh et al. teaches the application of a time-varying current in an electro-chemical mechanical polishing process to reduce the amount of polishing damage introduced into the substrate.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the polishing process of Wang et al. to include a time-varying electro-chemical current as taught by Uzoh et al. to provide an efficient and uniform polishing process capable of suppressing damage to the substrate.

Claims 43- 45 are rejected under 35 U.S.C. 103(a) as obvious over Wang et al., US6,440,295, in view of Forano, US6,149,781.

Wang et al. teach the above process for polishing a copper film formed on a semiconductor substrate, however the reference does not teach wiping the substrate to remove the surface of the metal film. Forano teaches the use of a resilient wiper blade, said blade optionally being perforated, for use during electro-chemical processing which results in the removal of gas bubbles from the workpiece surface and to remove a surface layer of partially depleted electrolytic solution from adjacent the workpiece.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the polishing process of Wang et al. to wipe the surface of the substrate to remove the surface of the metal film as taught by Forano to provide an efficient and uniform electro-chemical polishing process.

Conclusion

Remaining references cited of interest to show the state of the art.

No claim is allowed.

Papers relating to this application may be submitted to Technology Sector 1700 by facsimile transmission. Papers should be faxed to Crystal Plaza 3, Art Unit 1765,

using fax number (703) 305-6357. All Technology Sector 1700 fax machines are available to receive transmissions 24 hrs/day, 7 days/wk. Please note that the faxing of such papers must conform to the Notice published in the Official Gazette, 1096 OG 30, (November 15, 1989).

Any inquiry concerning this communication or earlier communications from the Examiner should be directed to Terrence Mackey whose telephone number is (703) 305-5504. The Examiner can normally be reached Monday - Friday from 7:00 AM – 4:30 PM.

If attempts to reach the Examiner by telephone are unsuccessful, the examiner's supervisor, Ben Uteck, can be reached at (703) 308-3836.

Any inquiry of a general nature or relating to the status of this application should be directed to the receptionist whose telephone number is (703) 308-0661.

ROBERT KUNEMUND
PRIMARY PATENT EXAMINER
A.U. 117

TMM

March 21, 2003